CONFIDENTIAL

M.R.P.1031
S.C.III/228

14th January, 1957

AIR MINISTRY

METEOROLOGICAL RESEARCH COMMITTEE

Draft Report of Chairman of the Physical Sub-Committee to the Meteorological Research Committee for the year ending 31st March, 1957

1. Constitution. The Sub-Committee was established by the Meteorological Research Committee in March, 1948. The membership at the end of the year under review was:-

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|---|---|
| Dr. T.W. Wormell (Chairman) | - Cambridge University |
| Dr. G.K. Batchelor | - Cambridge University |
| Instructor Commander K.A. Bowell | - Naval Weather Service |
| Professor S. Chapman | - - |
| Professor T.G. Cowling | - Leeds University |
| Dr. R.M. Goody | - Imperial College, London |
| Mr. A.S.G. Hill | - Ministry of Supply, Porton |
| Mr. F.H. Ludlam | - Imperial College, London |
| Dr. B.J. Mason | - Imperial College, London |
| Mr. B.C.V. Oddie | - A.D.M.O. (P.R.) |
| Dr. F. Pasquill | - Meteorological Office, Porton |
| Mr. D.G.A. Rendel | - Ministry of Supply, R.A.E. |
| Dr. G.D. Robinson | - Meteorological Office, Kew Observatory |
| Dr. J.M. Stagg | - P/D.D.M.O. |
| Dr. R.C. Sutcliffe | - D.D.M.O.(R) |

Dr. A.W. Brewer, Dr. G.M.B. Dobson and Mr. J. Paton of the main Committee were members of the Sub-Committee until November, 1956 when the Committee decided that its members should not be appointed to the Sub-Committees, except as Chairmen, but would continue to attend meetings of the Sub-Committees as appropriate. Professor S. Chapman's nine-year membership of the Sub-Committee ended on 31st March, 1957. Dr. B.J. Mason joined the Sub-Committee in December, 1956.

2. Meetings and papers. The Sub-Committee held five meetings at which 26 papers and reports were considered (see Appendix).

3. Present position regarding the more important items.

Considerable progress has been made at Porton in extending measurements of atmospheric diffusion to distances up to 50 miles and heights of about 5,000 ft., and some striking results have been obtained.

The study of humidity in the upper atmosphere by the M.R.F., hitherto confined to Great Britain, has now been extended by two series of flights, one over the Sahara and the other along a north-south line from 40°N. to 68°N. Observations of wind, velocity and temperature were also made during these flights.

The results of "rainmaking" operations are accumulating rather slowly, suitable occasions having proved much less common than was anticipated.

New investigations which are about to be undertaken concern atmospheric chemistry and the measurement of the concentration of Aitken condensation-nuclei at ground level.

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The following notes refer briefly to some of the more important and interesting items. The item numbers are those of M.R.P. 967A "Programme of Investigations, 1956/57".

(a) Gradients of temperature, humidity and wind over the sea - III.1(c). Two sets of profile observations obtained at Ocean Weather Station I are being investigated.

## Microphysics of water in the atmosphere

(b) Atmospheric nuclei - III.2(a). The M.R.F. has developed a method, based on the Liesegang Ring technique, for counting and measuring giant salt particles in the atmosphere.

At its 40th meeting the Physical Sub-Committee agreed that regular counts of Aitken nuclei ought to be made at a few places in Great Britain, and Kew have already constructed the first of the automatic counters (Pollak type) which it is proposed to use.

(c) Clouds - III.2(b). Work on the microphysics of clouds by the M.R.F. was largely in abeyance, pending the development of satisfactory instruments: but in the autumn the subject suddenly acquired urgent importance because of the failure of the Britannia aircraft's engine in ice-clouds. A number of instruments, mostly insufficiently developed, were fitted to the Britannia for an intensive study of clouds causing failure, particularly tropical cumulus and the extensive cirrus masses associated with them, and a considerable accumulation of data has resulted. This is being analysed: it is of great interest because little microphysical information on such clouds has hitherto been available, but unfortunately it is not entirely reliable nor easy to interpret, owing to the deficiency of the instruments.

(d) Physical structure of rain-producing clouds - III.2(d)(i). M.R.P. 980 contained the results of some flights through large cumulus clouds by the M.R.F. At East Hill, a study of the radar signal-intensity from steady frontal rain (M.R.P. 984) suggests that there is very little increase in the size of raindrops during their fall from the melting level to the ground.

(e) Drop-size distribution in rain - III.2(d)(iii). Some interesting observations have been made by the M.R.F. using their new aluminium foil type of recorder. This has been found capable of detecting the larger cloud-droplets and a study is being made of their distribution in small cumulus clouds.

(f) Artificial production of rain and dispersal of cloud - III.2(d)(iv). The full scale trials of the seeding of warm-front clouds, using ground based silver-iodide generators, have continued. The total number of experiments up to December 31st, 1956 was 19. All the preliminary statistical work - the selection and tabulation of "historical occasions" for comparison with the occasions of seeding - has been completed, and the first seeding trials have been analysed. As was to be expected, no result of seeding can yet be detected. Meanwhile, the Physics Department at Porton has carried out a laboratory examination of the performance of the generator: the results have not yet been reported, but it is understood that the yield of effective freezing nuclei is very much less than had been hoped.

(g) Contrails - III.2(f). M.R.P. 979 gave the results of the M.R.F.'s measurements of the heights of contrail formation and their relationship to meteorological conditions. On the basis of this work it has been possible to issue an improved set of rules for the forecasting of contrails. No further experimental work is contemplated at present.

/Atmospheric

## Atmospheric turbulence

(h) Small-scale turbulence in the lower atmosphere - III.3(d). The staff of Kew and Cambridge have continued to work on this problem, using a site on an abandoned R.A.F. airfield at Graveley. Attention has been devoted to the recording of fluctuations of wind and temperature with a resolution of about 1/50 sec. The analysis of results is proceeding.

## Experimental study of diffusion of matter - III.3(f).

(j) Medium range diffusion - III.3(f)(ii). Experiments have continued using fluorescent particles released at ground level and sampled at distances up to about 50 miles downwind and at heights up to 5,000 ft. The results from experiments during the period September, 1955 to March,1956 have been presented in M.R.P. 1008 (Restricted). It has been found, however, that the use of a single aeroplane for sampling is unsatisfactory, and in addition there are great operational as well as technical difficulties when sampling in cloud. For these reasons the use of samplers attached to the cable of a captive balloon, rejected in the earlier planning of the experiment, is being reconsidered.

(k) Eddy structure and vertical diffusion in the first few thousand feet - III.3(f)(iii). Equipment, which can be carried on the cable of a captive balloon, for measuring fluctuations of total wind speed and of inclination of the wind to the horizontal has been developed at Porton, and has been used at Cardington to study wind-fluctuations up to heights exceeding 5,000 ft. A report is being prepared. Porton have also developed a method of studying the distribution in a vertical plane of lycopodium spores released continuously from an apparatus carried at any required height on a balloon-cable. Some results are contained in M.R.P. 1006. The principal deduction is that the direction of motion of a small sample of air is a remarkably conservative property, the motion being, in general, almost rectilinear for periods of a minute.

(l) Diffusion of pollution from chimneys - III.3(h). A study has been made of the distribution of sulphur dioxide pollution around an isolated power station. The observations can be explained by a conventional treatment of diffusion in terms of the power station output and the wind distribution in speed and direction. A report will be submitted to the Sub-Committee.

## Radiation

(m) Solar radiation - total, diffuse and according to spectral region - III.4(a). The national network of observing stations has been greatly extended during the year. Total and diffuse radiation are now recorded continuously at Lerwick, Eskdalemuir, Cambridge, Victory House, Kew and Aberporth. Promising results have also been obtained during a trial on an Ocean Weather Ship.

## Meteorological factors affecting agriculture

(n) Measurement of water deposited in dew and hoar frost - III.6(b). The Meteorological Office is co-operating with plant pathologists in the study of leaf wetness, temperature, humidity and rainfall within crops. A wetness recorder devised by the Office in liaison with Rothamsted is being used.

(p) Liability to frost of particular localities - III.6(c). Investigations made at Rosemaund Experimental Husbandry Farm have been reported in the Meteorological Magazine; further work is in progress at this site. Analysis has been made of observations made at Tillington, near Hereford, and also of observations made during mobile surveys by car on selected mornings in undulating country to the north of Harrow.

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(q) Effect of barriers on the micro-climate of an adjacent area - III.6(e). Field observations are being made in the Bristol area of wind speed (and occasionally other elements) within a shelter screen of lath fencing 3 ft. high and on either side of a high fence, of various materials, 100 ft. long and 40 ft. high.

Study of visibility from the air

(r) Relation between air-to-ground and horizontal visibilities - III.7(b). A new programme of research, based on the use of lights and targets carried at various heights on the cable of a captive balloon, has been worked out. It is hoped to carry out these investigations in four different types of locality, although work can only begin at once at one station, Cardington.

(s) Visibility of ground from aircraft at great heights and above cirrus cloud - III.7(c). Five years' reports (OVBIS) obtained from the Bismuth meteorological reconnaissance flights have been assembled for analysis.

Stratospheric phenomena

(t) Temperature, water content and ozone of the troposphere and lower stratosphere under various conditions, including exploration of jet streams - III.8(d). The latest measurements of humidity over this country are summarised in M.R.P. 976.

A series of flights was made by the M.R.F.'s Canberra over North Africa in June, and during the latter part of the summer a number of meridional flights were made from about latitude 40°N. to latitude 68°N. In all flights temperature, humidity and wind velocity in the neighbourhood of the tropopause were studied; ozone measurements, unfortunately, have not been satisfactory, though they were attempted in the earlier flights. Reports are in course of preparation. Much valuable information on the wind-distribution in and around jet streams has been obtained. The analysis is unfortunately very laborious, and is proceeding very slowly because sufficient time cannot be allotted to the work.

Not included in the Programme for 1956/57

It was decided by the Physical Sub-Committee at its 38th meeting that it would be desirable for the Meteorological Office to take part, at least during the International Geophysical Year, in the programme of measurements in the field of atmospheric chemistry which has been organized by Prof. Rossby and adopted by most countries of Northwest Europe. Arrangements are being made to set up six stations in Great Britain.

Appendix to M.R.P.1031 (Report of Chairman of S.C.III)
List of papers and reports considered by the Physical Sub-Committee in the year ending 31st March, 1957

| M.R.P. | Title | Author |
|---|---|---|
| 971 | Variation of visibility in fog at Exeter Airport, and the time of fog dispersal. | W.E. Saunders |
| 972 | Water loss from various cropped surfaces. | N.E. Rider |
| 973 | Evaporation from a saturated rough surface into a turbulent air stream. (Porton Technical Paper No. 533). | J.S. Hay |
| 975 | First report of Cloud Seeding Panel. | - |
| 976 | Further observations of humidity up to 50,000 feet made from aircraft of the Meteorological Research Flight in 1955. | N.C. Helliwell, J.K. Mackenzie and M.J. Kerley |
| 979 | Further observation of condensation trails. | N.C. Helliwell and J.K. Mackenzie |
| 980 | Further observations of large cumuliform clouds by the Meteorological Research Flight. | G. J. Day |
| 982 | Cloud-seeding operations - October 22nd to November 18th, 1955.<br>A note on M.R.P.982. | B.C.V. Oddie and N.C. Helliwell<br>B.C.V. Oddie |
| 984 | Variation with height of rainfall below the melting level. | W.G. Harper |
| 990 | The exhaust trail from jet engines. | R.F. Jones |
| 991 | Droplet sampling in cumulus clouds.<br>A note on M.R.P. 991. | W.G. Durbin<br>B.C.V. Oddie |
| 992 | Second Report of Cloud Seeding Panel. | - |
| 993 | Chemical sampling of air and rainwater. | R.M. Goody and P.A. Sheppard |
| 996 | Condensation trails formed by jet aircraft. | J. Briggs |
| 998 | The measurements of natural freezing nuclei made by the Meteorological Research Flight during January, 1956. | R.J. Murgatroyd and M.P. Garrod |
| 999 | Opinions on the practicability of an incompressible fluid model for the study of two-dimensional airflow over a ridge (proposed by Mr. J.S. Sawyer in M.R.P.935). | - |
| 1004 | Twenty-fourth S.C.III Progress Report (March to August, 1956). | - |
| 1006 | Measurements of the short range diffusion of airborne particles at a height of a few hundred feet in the atmosphere. (Porton Technical Paper No. 561). | J.S. Hay and F. Pasquill |

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